Town of Amherst
Department of Public Works

SECTION 7

MassDEP Final Comprehensive Site Assessment (Permit Approval)

COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENERGY & ENVIRONMENTAL AFFAIRS
DEPARTMENT OF ENVIRONMENTAL PROTECTION
WESTERN REGIONAL OFFICE
436 Dwight Street • Springfield, Massachusetts 01103 • (413) 784-1100

DEVAL L. PATRICK
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Lieutenant Governor

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Secretary

LAURIE BURT
Commissioner

APR 0 6 2010

Town of Amherst
Department of Public Works
586 South Pleasant Street
Amherst, MA 01002
Attention: Guilford Mooring, Supt.

Re: Amherst-DSWM-Landfill
Old Amherst Landfill
Route 9 (South Side)
Final Comprehensive Site Assessment
Permit Approval
10-008-001
BWPSW23
Transmittal #X226691

Dear Mr. Mooring:

The Department of Environmental Protection (the MassDEP) has completed review of the Final Comprehensive Site Assessment (Final CSA) Report for the Old Amherst Landfill (the "Old Landfill", hereinafter referred to in this document as "the landfill"), located south of Route 9 (Belchertown Road) in Amherst. The Final CSA Report was prepared by Tighe & Bond, Inc. (T&B), on behalf of the Town of Amherst (the Town), and was submitted to the Department on January 30, 2009 in accordance with previous MassDEP requirements. On May 21, 2009, MassDEP's Office of Research & Standards (ORS) issued a review of the Focused Risk Characterization for MADEP-Specified Sediments, Old Amherst Landfill (copy attached).

A comprehensive summary of previous assessment results was contained in the MassDEP's October 23, 2007 review of the Interim CSA Report. This review of the Final CSA will summarize only the new assessment results contained in the Final CSA.

Summary of Final Comprehensive Site Assessment

Final CSA assessment activities consisted of the following:

- The private well survey was updated as of February, 2008 for the areas within a half-mile of the landfill and also extending

downgradient of the landfill to the Fort River and Hop Brook, by continuing comparison of Assessor records to Water Department records.

- Twelve additional groundwater monitoring wells were installed, including one upgradient well, two downgradient shallow wells, three downgradient cluster wells (shallow and deep), one mid-level cross-gradient well, one downgradient deep bedrock well, and one cross-gradient, deep bedrock well. Including previously installed wells, there are a total of 28 groundwater monitoring wells at the landfill site.
- Hydraulic conductivity testing was performed on all new groundwater monitoring wells and selected previous wells.
- Groundwater samples were obtained during one monitoring round in October, 2008 from 11 previously existing groundwater monitoring wells, the 12 new groundwater monitoring wells, and from one new landfill gas well.
- A groundwater contour and flow map was prepared from the August, 2008 groundwater elevation data;
- Surface water samples were obtained during one monitoring round in October, 2008 from 8 previous surface water locations around the landfill, and from 10 additional surface water locations, for a total of 18 locations.
- Groundwater and surface water samples were generally analyzed for the parameters outlined at 310 CMR 19.132(h)(1-3), including RCRA 8 metals (as dissolved metals), and volatile organic compounds (VOCs) by EPA Method 8260(including Tentatively Identified Compounds, or TICs).
- Sediment samples were obtained during one monitoring round in May 2008 from nine locations around the landfill, and were analyzed for the parameters outlined at 310 CMR 19.132(h)(1-3), including Priority Pollutant metals and VOCs by EPA Method 8260 (including TICs);
- Additional sediment samples were obtained during one monitoring round in October 2008 from nineteen locations at three selected areas around the landfill where initial sampling showed some elevated metals results (Gull Pond inlet, KC Trail wetland, and the wetland west of Hop Brook Drive), and were analyzed for selected metals, including arsenic, cadmium, and/or mercury.
- Two additional landfill gas (LFG) monitoring wells were installed along the northern and western perimeter of the landfill; these wells, the seven existing LFG monitoring wells, and the existing, shallow LFG monitoring points were monitored during one round in October, 2008 for combustible gas (%Lower Explosive Limit, or %LEL, as methane), %carbon dioxide, %oxygen, carbon monoxide, and hydrogen sulfide.
- The geologic stratigraphy of the site was outlined, via cross-sections.
- A site mass-water balance evaluation was performed using the HELP model.
- Contamination migration pathways were described.
- A Qualitative Baseline Risk Assessment was performed, and

- A Focused Quantitative Risk Characterization was performed for arsenic and cadmium contaminated sediments in the area of the KC trail and arsenic contaminated sediments at the Gull Pond inlet.

The results of the Final CSA assessment work at the landfill were the following:

- The updated private well survey revealed that all residences and other buildings within the survey area are serviced by the Amherst public water system, except for 24 private wells, all located upgradient (east) of the landfill, on either Harkness Road or Belchertown Road. **No private wells were identified downgradient of the landfill in the survey area.**
- The updated, August 2008 groundwater map again shows that groundwater flow is generally from east to west in the landfill vicinity, discharging to Hop Brook, its wetlands and tributaries. Similar to the conclusion previously reached in the Interim CSA Report, T&B states that groundwater flow from the landfill does not extend south or east of monitoring well 1-03, which is located approximately 1,000 feet southwest of the landfill **(i.e., groundwater does not flow from the landfill towards the Lawrence Swamp public supply wells, which are located over one mile to the south/southeast).**
- Hydraulic conductivity (k) testing showed the following: k values for the surficial aquifer ranged from 0.2 feet per day (ft/day) to 110 ft/day; k values for the confining layer ranged from 2 to 10 ft/day; k values for the confined aquifer ranged from 5 to 35 ft/day; and k values for the bedrock aquifer ranged from 0.1 to 6 ft/day.
- The HELP site mass-water balance modeling showed that approximately 940 gallons/acre/day of leachate are produced by precipitation infiltrating through the existing landfill cap.
- **Groundwater** analytical results were compared to the MassDEP's Bureau of Waste Site Cleanup (BWSC) GW-1 groundwater standards (the GW-1 standards), which are equivalent to the Massachusetts Drinking Water Standards & Guidelines (Maximum Contaminant Levels, or MCLs).
- VOCs were generally non-detectable (ND) in all groundwater monitoring wells, except that trace levels of VOCs at levels below the GW-1 standards were present in the following monitoring wells: wells 3-68, 6-89 and 3-80 located west of the landfill adjacent to the Hop Brook wetlands; well 2-08 (shallow) and well 5-08 (bedrock) located immediately downgradient (west) of the landfill; well 6-08 near Gull Pond; well 8-08 south of Hop Brook Drive; and wells 10-08 and 11-08 located just west of Wildflower Drive near the KC Trail. All VOC levels were also below all GW-2 and GW-3 groundwater standards.
- The seven monitoring wells located to the south of well 1-03, towards the Lawrence Swamp public supply wells, were ND for all VOCs, except for trace levels of the following VOCs: the

Tentatively Identified Compounds (TICs) ethanethiol and 1-propanethiol found in well 1-83 at 4 micrograms/liter (ug/l) and 2 ug/l, respectively; the TIC ethanethiol found in well 1-83 at 4 ug/l; and the VOCs acetone and chloromethane (estimated at 28 ug/l and 0.5 ug/l, respectively) found in the bedrock well 4-08 located off Station Road. These VOCs are all well below the applicable GW-1/MCL standards, where such standards exist, and do not appear to be attributable to the landfill. The Lawrence Swamp public supply wells are regularly monitored according to the MassDEP's Division of Water Supply (DWS) requirements, and have shown no impact from the landfill.

- Metals and indicator parameters were elevated in monitoring wells located downgradient (west) of the landfill, from the MW-6-08/7-08 monitoring well cluster located just south of Gull Pond, southward to the MW-8-08/9-08 monitoring well cluster located just south of Hop Brook Drive. There were two exceedances of the MassDEP's GW-1 groundwater standards for metals, with the arsenic GW-1 standard of 10 micrograms/liter (ug/l) exceeded in monitoring well 2-08 located adjacent to the landfill (at 25 ug/l) and in monitoring well 10-08 located just west of Wildflower Drive near the KC Trail (at 20 ug/l). There were no exceedances of the MassDEP's GW-3 standards for metals (the arsenic GW-3 standard is 900 ug/l); GW-2 standards are not applicable to metals.
- **Surface water** sample results were compared to the USEPA Water Quality Criteria (WQC) recommended standards for surface water quality.
- All surface water samples were ND for all VOCs, except for the TIC ethyl ether present at 1 ug/l at sampling location SW-8 in the Hop Brook wetland near monitoring well 3-68; this level is well below the MassDEP BWSC Reportable Concentration GW-1 standard of 1,000 ug/l for ethyl ether (there are no WQC standards for VOCs);
- Surface water samples were at or below the WQC standards for metals and indicator parameters at all sampling locations, except for: iron at three locations (SW-1, the visibly-impacted impoundment which flows into Gull Pond; SW-14 by the KC Trail, and SW-15 in the wetland off the end of Hop Brook Drive); lead at locations SW-15 A&B (off the end of Hop Brook Drive) which exceeded the WQC chronic standard of 3.2 ug/l, but was less than the WQC acute standard of 83 ug/l and the Drinking Water standard of 15 ug/l; and cyanide at location SW-6 at 7 ug/l, which slightly exceeded the WQC chronic criteria of 5.2 ug/l, but was less than the WQC acute criteria of 22 ug/l and the Drinking Water standard of 200 ug/l;
- The downstream surface water sample from Hop Brook showed slightly elevated levels of iron, manganese and barium versus the upstream sample, with both upstream and downstream samples below all WQC chronic and acute standards;
- **Sediment** sample results were compared to the MassDEP Revised Stage I Freshwater Sediment Screening Criteria (SSC) guidelines.

- Sediment samples were ND for VOCs, except for low levels of acetone and methyl-ethyl ketone (MEK) in sample SED-1 at the impoundment flowing into Gull Pond, MEK at SED-6 at the KC Trail, and MEK at SED-15 in the wetland off the end of Hop Brook Drive There are no SSC guidelines for VOCs, however the VOC levels were well below the MassDEP's S-1, GW-1 soil standards for these compounds.
- Sediment samples were below the SSC guidelines for metals and indicator parameters except for the following: sediment samples SED-15, 15A & 15B in the wetland off the end of Hop Brook Drive), which contained mercury up to 0.5 mg/kg, above the SSC guideline of 0.18 mg/kg but well below the S-1, GW-1 soil standard of 10 mg/kg; samples SED-1, SED-1A & SED-1B, at the impoundment flowing into Gull Pond, which contained arsenic up to 130 milligrams/kilogram, above the SSC guideline of 33 mg/kg; and samples SED-6, SED-6K, SED-14, & SED-16, at the KC Trail location, which contained arsenic up to 260 mg/kg in the center of the wetland, above the SSC guideline of 33 mg/kg, and cadmium up to 11mg/kg, above the SSC guideline of 5 mg/kg.
- As required by MassDEP, a focused Quantitative Risk Assessment was completed by KERA Environmental, LLC in accordance with MassDEP BWSC protocol, guidance and regulations, for the sediments with elevated levels of arsenic and cadmium at the KC trail, and for the sediments with elevated levels of arsenic at the Gull Pond inlet, as described above. The results of the Risk Assessment concluded that the sediments posed No Significant Risk to Human Health in accordance with MassDEP BWSC standards, and the MassDEP's Office of Research & Standards agreed with this conclusion of No Significant Risk in its May 18, 2009 review memorandum.
- The downstream sediment sample from Hop Brook showed lower levels of metals and indicator parameters versus the upstream sample, except for lead, which was slightly higher downstream than upstream; all samples were below all WQC chronic and acute standards and were ND for VOCs;
- **Landfill gas** (LFG) was not detected at all nine perimeter LFG monitoring wells, and at all of the shallow LFG monitoring probes along the western perimeter, with all LFG monitoring wells and monitoring points at 0% LEL and 0 ppm hydrogen sulfide.

T&B completed a Qualitative Risk Assessment in accordance with the requirements and guidance of the MassDEP's Landfill Technical Guidance Manual (the LAC), revised in May, 1997, which evaluated all potential human health exposure routes in all media (groundwater, surface water, sediment, soil, landfill gas) from any contamination from the landfill, based on the updated sampling and analysis results from the Final CSA. **The Qualitative Risk Assessment concluded that there were no significant risks to human health or public safety posed by the landfill. As noted previously, the Focused Quantitative Risk Assessment concluded that sediments with elevated levels of metals at the KC Trail and**

Gull Pond inlet posed No Significant Risk to human health.

Recommendations by T&B

T&B recommends the following regularly-scheduled maintenance and monitoring be performed at the landfill:

- Annual sampling of one upgradient groundwater monitoring well (MW-01-08) and seven downgradient groundwater monitoring wells (MW-6-08, MW-8-08, MW-9-08, MW-10-08, MW-11-08, MW-1-03, & MW-12-08);
- Annual sampling of four surface water locations (SW-1/Gull Pond Inlet, SW-2/Gull Pond, SW-6/KC Trail, and SW-15/Hop Brook Drive Wetland);
- Analysis of groundwater and surface water samples for the parameters outlined at 310 CMR 19.132(h)(1-3);
- Semi-annual LFG monitoring of the nine LFG monitoring wells for % Lower Explosive Limit (%LEL), % oxygen, and hydrogen sulfide; and
- Maintenance of settlement areas on the landfill cap to eliminate stormwater ponding areas and promote stormwater drainage off the cap.

Potential Post-Closure Uses

As summarized in the MassDEP's October 23, 2007 review of the Interim CSA, Interim CSA assessment work performed within the perimeter of the landfill indicated that post-closure use of significant portions of the landfill may be possible. The landfill cap is at least 24 inches thick in almost all areas, with generally a 6-inch thick impermeable layer, and the topsoils of the cap appear to represent clean, "background" soil conditions. Field monitoring of ambient air at breathing zone height above the surface of the landfill cap, and in the topsoil above the impermeable layer of the cap, did not show measurable levels of methane (%LEL) or hydrogen sulfide, and showed atmospheric levels of oxygen.

If the Town wishes to seek post-closure use(s) for the landfill, a post-closure use permit application which complies with the requirements of 310 CMR 19.143 must be submitted to the MassDEP for review and approval, prior to any such use, which must contain specific plans, including written descriptions, figures showing exact locations of any proposed usage(s), and engineering plans and specifications, for any proposed uses.

MASSDEP DETERMINATIONS

Personnel of the MassDEP have reviewed the Final CSA report and permit application for the landfill in accordance with MGL c. 111 s. 150A, MGL c. 30A, 310 CMR 19.000, and the MassDEP's publication

Standard References for Monitoring Wells (WSC-310-91). The MassDEP has determined that the Final CSA report is acceptable in accordance with MGL c. 111, s. 150A and MGL c. 30A, subject to the conditions and requirements outlined below.

1. The Town of Amherst (the Town) should not allow the installation of any private (or public) water supply wells within the following area: from the landfill perimeter westward to the Fort River (bounded on the north by a line from the northwest corner of the landfill through surface water location SW-10); and from the landfill perimeter westward and southwestward to Hop Brook (bounded on the east by a line from the southwest corner of the landfill through monitoring well MW-1-94). The Town shall update the private well survey within this area on a biannual (every two years) basis, to be performed as previously, by comparison of Assessor records to Water Department records. The results of the updated survey shall be included in the annual report for the landfill, as outlined below at Condition 11 of this permit approval. If any private wells are identified in this area, MassDEP shall be notified immediately upon discovery.

2. Groundwater samples shall be obtained on an annual basis by December 31 of each calendar year for a minimum of two years from the following groundwater monitoring wells: 1-08,2-08,3-08,4-08,5-08,6-08,7-08,8-08,9-08,10-08,11-08,12-08,1-03,2-03, & 3-68. Following this two year period, the Town may petition MassDEP to reduce the number of groundwater monitoring wells required to be sampled. Groundwater monitoring wells shall be sampled in accordance with the procedures outlined in the MassDEP's publication Standard References for Monitoring Wells (WSC-310-91). Sampling can alternatively be performed in accordance with the USEPA publication Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells, dated July 30, 1996.

3. Surface water samples shall be obtained on an annual basis by December 31 of each calendar year for a minimum of two years from the following surface water locations: (SW-1/Gull Pond Inlet, SW-2/Gull Pond, SW-4/Hop Brook Upstream, SW-5/Hop Brook Downstream, SW-6/KC Trail, & SW-15/Hop Brook Drive Wetland). Following this two year period, the Town may petition MassDEP to reduce the number of surface water locations required to be sampled.

4. Groundwater and surface water samples shall be analyzed for the parameters outlined at 310 CMR 19.132(h)(1-3), including RCRA 8 metals (as dissolved metals), and VOCs by EPA Method 8260 (including Tentatively Identified Compounds, or TICs), with lower VOC detection limits for surface water.

5. All VOC analyses by EPA Method 8260 shall be performed as outlined in 310 CMR 19.132(h)(1-3), specifically methyl ethyl

ketone, methyl isobutyl ketone, acetone, and 1,4-dioxane shall be included, and unknown peaks having intensities greater than 5 times the background intensity shall be identified. As outlined at 310 CMR 19.132(i), detection limits for all parameters tested, including 1,4-dioxane, shall be at or below the MCL/GW-1 standards.

6. Quality Assurance/Quality Control Plan (QA/QC) protocols for all environmental monitoring should generally follow those outlined in the MassDEP's LAC and Standard References manuals.

7. Monitoring of existing LFG wells PGW-1 through PGW-9 and all existing shallow LFG monitoring points shall be performed on a semi-annual basis, by July 1 and December 31 of each calendar year, with one round performed during the winter months, in frozen ground conditions. LFG monitoring shall be performed as outlined on p. 4-16 and 4-17 of the LAC manual for % Lower Explosive Limit (% LEL), % oxygen, and hydrogen sulfide. If LFG levels exceed 25% LEL at the property line, the MassDEP shall be notified within 24 hours, as outlined in 310 CMR 19.132(4)(h), and the Town shall either monitor the residence(s) near the exceedance or monitor LFG monitoring wells closer to the residences for the same parameters. If LFG levels exceed 10% LEL within any building, the MassDEP shall be notified within two hours, as outlined in 310 CMR 19.132(4)g), and the Town shall take immediate action to protect public health and safety. LFG monitoring data shall be submitted to MassDEP within 30 days of the date of monitoring, unless LFG exceedances trigger shorter reporting requirements as outlined above.

8. The Town shall perform the following activities at the landfill facility as described in 310 CMR 19.142, Landfill Post-Closure Requirements, of the Solid Waste Management Facility Regulations, and as further specified in this permit:

   (a) take corrective actions to remediate and/or mitigate conditions that would compromise the integrity of the final cover;
   (b) maintain the integrity of the final cover system;
   (c) monitor and maintain the environmental monitoring systems for surface water, groundwater, and air quality;
   (d) maintain access roads;
   (e) maintain landfill gas control systems; and
   (f) protect and maintain surveyed benchmarks.

9. The post-closure maintenance program at the landfill shall be performed by the Town as required in 310 CMR 19.143, and shall include:

   (a) Cutting vegetation over the entire landfill, at a

minimum frequency of once per year to prevent the establishment of deep-rooted vegetation;
(b) Semi-annual inspections for settlement and erosion;
(c) Semi-annual inspection of stormwater drainage swales and retention basins for soil build up and periodic cleaning as necessary;
(d) Repairs of the landfill cap, stormwater structures, or other landfill appurtenances; and
(e) Maintenance of the access road such that the road remains passable to maintenance/repair vehicles.

10. All maintenance/repair of final cover system components or associated landfill appurtenances conducted as a result of storm damage, erosion, or other circumstances shall be summarized and reported by the Town to the MassDEP within thirty (30) days of the date of the repair/maintenance.

11. The Town shall submit an annual post-closure report, as required by 310 CMR 19.142 (6) Reporting Requirements, not later than February 15th of each year, which shall contain the following information for the previous calendar year:

(A) Tabular summaries of all analytical and monitoring data performed during the year;
(B) Laboratory data sheets for all sample analyses performed during the year;
(C) A description of all post-closure maintenance and monitoring performed during the year; and
(D) The updated private well survey results (to be performed every other calendar year).

12. Appropriate Health & Safety (H&S) measures shall be utilized for all assessment work at the landfill.

Pursuant to 310 CMR 19.037(5), any person aggrieved by the issuance of this approval, except as provided for under 310 CMR 19.037(4)(b), may file an appeal for judicial review of said decision in accordance with the provisions of M.G.L. c. 111, s. 150A and C. 30A not later than thirty [30] days following notice of this decision. The standing of a person to file an appeal and the procedures for filing such appeal shall be governed by the provisions of M.G.L. c. 30 A. Unless the person requesting an appeal requests and is granted a stay of the terms and conditions of the permit by a court of competent jurisdiction, the permit decision shall remain effective or become effective at the conclusion of the 30 day period.

Any aggrieved person intending to appeal the decision to the superior court shall provide notice to the MassDEP of said intention to commence such action. Said Notice of Intention shall include the MassDEP File Number (10-008-002) and shall identify with particularity the issues and reason(s) why it is believed the approval decision was not proper. Such notice shall be provided to

the Office of General Counsel of the MassDEP and the Regional Director for the regional office which made the decision.

The appropriate addresses to which to send such notices are:

General Counsel
Department of Environmental Protection
One Winter Street-Third floor
Boston, MA 02108

&

Regional Director
Department of Environmental Protection
436 Dwight Street - 5th Floor
Springfield, MA 01103

No allegation shall be made in any judicial appeal of this decision unless the matter complained of was raised at the appropriate point in the administrative review procedures established in those regulations, provided that matter may be raised upon a showing that it is material and that it was not reasonably possible with due diligence to have been raised during such procedures or that matter sought to be raised is of critical importance to the public health or environmental impact of the permitted activity.

The MassDEP reserves the right to require additional investigatory or remedial work for the landfill, including the installation of additional monitoring wells or alternative remedial measures, if monitoring results indicate such a need. If you should have any questions or comments regarding this correspondence please contact Larry Hanson of this office, at #413-755-2287.

Sincerely,

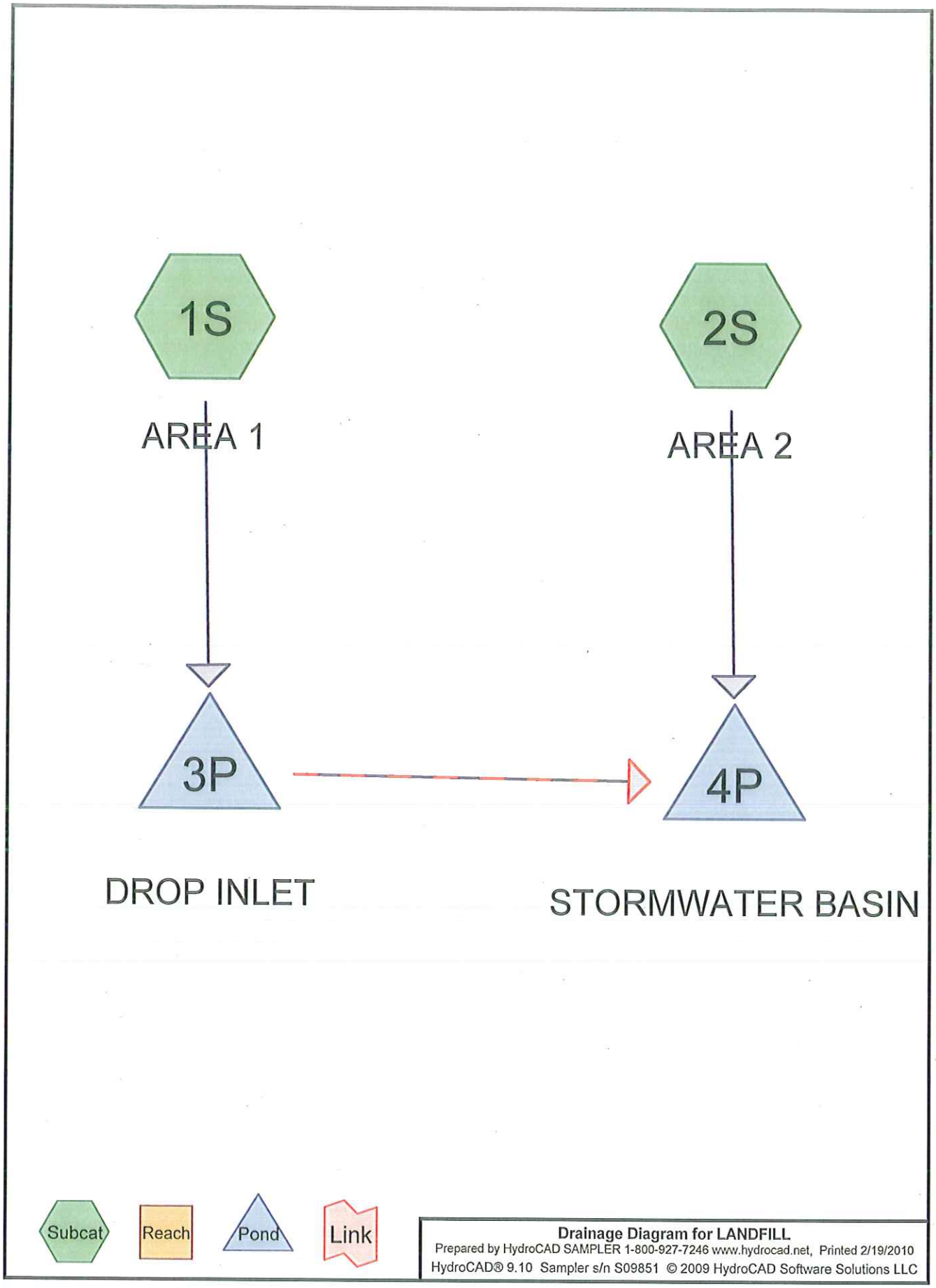
Daniel Hall
Section Chief
Solid Waste Management

cc: Amherst Town Manager - Laurence Shaeffer
Amherst Health Dept. - Director
Amherst Water Dept. - Robert Pariseau
T&B, Inc. - Jeffrey Thelen
DEP/WERO/DWS - Douglas Paine

Town of Amherst
Department of Public Works

SECTION 8

Sedimentation Basin Sizing, HydroCAD Report



Drainage Diagram for LANDFILL

Prepared by HydroCAD SAMPLER 1-800-927-7246 www.hydrocad.net, Printed 2/19/2010

HydroCAD® 9.10 Sampler s/n S09851 © 2009 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
9.050	71	Meadow, non-grazed, HSG C (1S, 2S)
0.660	89	Gravel roads, HSG C (1S, 2S)
1.750	91	Newly graded area, HSG C (1S)
0.200	98	Paved roads w/curbs & sewers, HSG D (2S)
11.660		**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
11.460	HSG C	1S, 2S
0.200	HSG D	2S
0.000	Other	
11.660		**TOTAL AREA**

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Fill (inches)
1	3P	272.00	269.00	26.0	0.1154	0.011	15.0	0.0	0.0
2	4P	260.90	260.80	100.0	0.0010	0.011	15.0	0.0	0.0

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: AREA 1 Runoff Area=7.980 ac 0.00% Impervious Runoff Depth>0.86"
Flow Length=1,077' Tc=7.1 min CN=76 Runoff=8.00 cfs 0.575 af

Subcatchment 2S: AREA 2 Runoff Area=3.680 ac 5.43% Impervious Runoff Depth>0.76"
Flow Length=1,064' Tc=29.4 min CN=74 Runoff=1.92 cfs 0.233 af

Pond 3P: DROP INLET Peak Elev=273.04' Storage=2,892 cf Inflow=8.00 cfs 0.575 af
Primary=3.81 cfs 0.527 af Secondary=3.74 cfs 0.044 af Outflow=7.55 cfs 0.571 af

Pond 4P: STORMWATER BASIN Peak Elev=263.87' Storage=32,892 cf Inflow=8.43 cfs 0.804 af
Primary=0.08 cfs 0.049 af Secondary=0.00 cfs 0.000 af Outflow=0.08 cfs 0.049 af

Total Runoff Area = 11.660 ac Runoff Volume = 0.808 af Average Runoff Depth = 0.83"
98.28% Pervious = 11.460 ac 1.72% Impervious = 0.200 ac

Summary for Subcatchment 1S: AREA 1

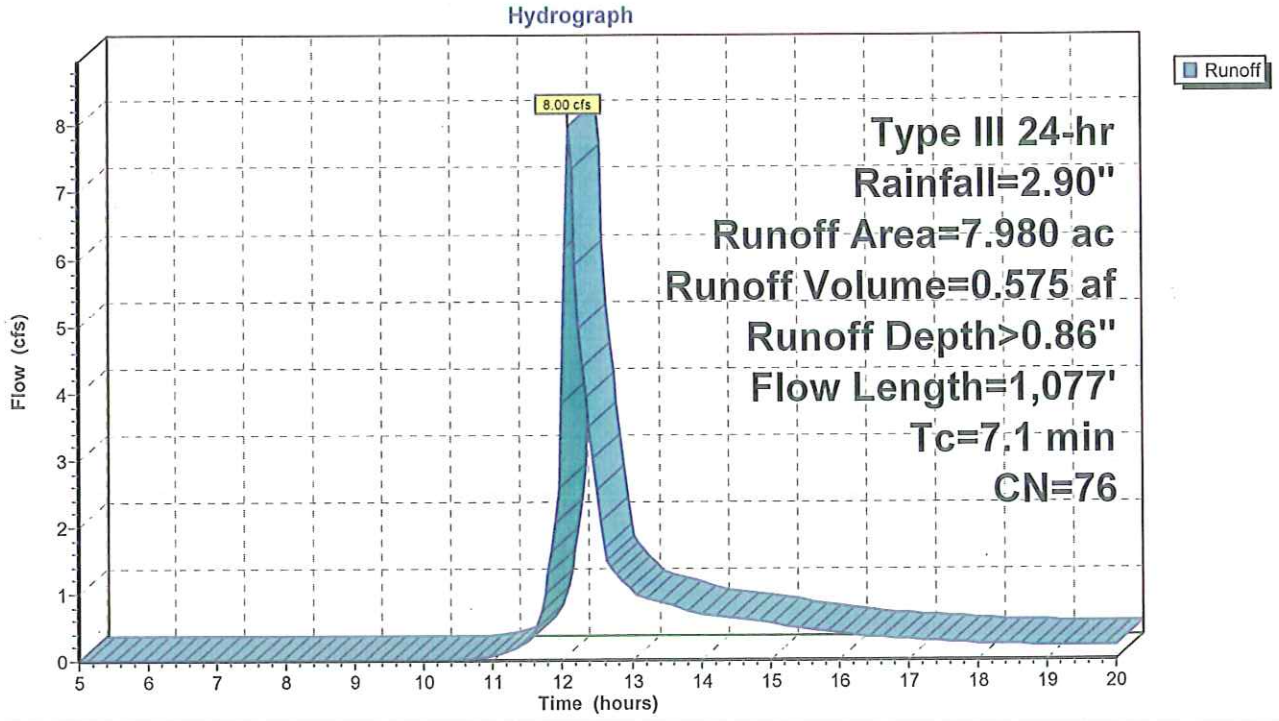
Runoff = 8.00 cfs @ 12.11 hrs, Volume= 0.575 af, Depth> 0.86"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=2.90"

Area (ac)	CN	Description
0.300	89	Gravel roads, HSG C
5.930	71	Meadow, non-grazed, HSG C
1.750	91	Newly graded area, HSG C
7.980	76	Weighted Average
7.980		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0200	1.16		**Sheet Flow, NEWLY GRADED** Smooth surfaces n= 0.011 P2= 3.00"
4.3	562	0.0184	2.18		**Shallow Concentrated Flow, NEWLY GRADED** Unpaved Kv= 16.1 fps
1.0	292	0.0300	4.83	32.37	**Channel Flow, RIP RAP SWALE** Area= 6.7 sf Perim= 10.3' r= 0.65' n= 0.040 Earth, cobble bottom, clean sides
1.1	173	0.0050	2.63	17.62	**Channel Flow, GRASS SWALE** Area= 6.7 sf Perim= 10.3' r= 0.65' n= 0.030 Earth, grassed & winding
7.1	1,077	Total			

Subcatchment 1S: AREA 1



Summary for Subcatchment 2S: AREA 2

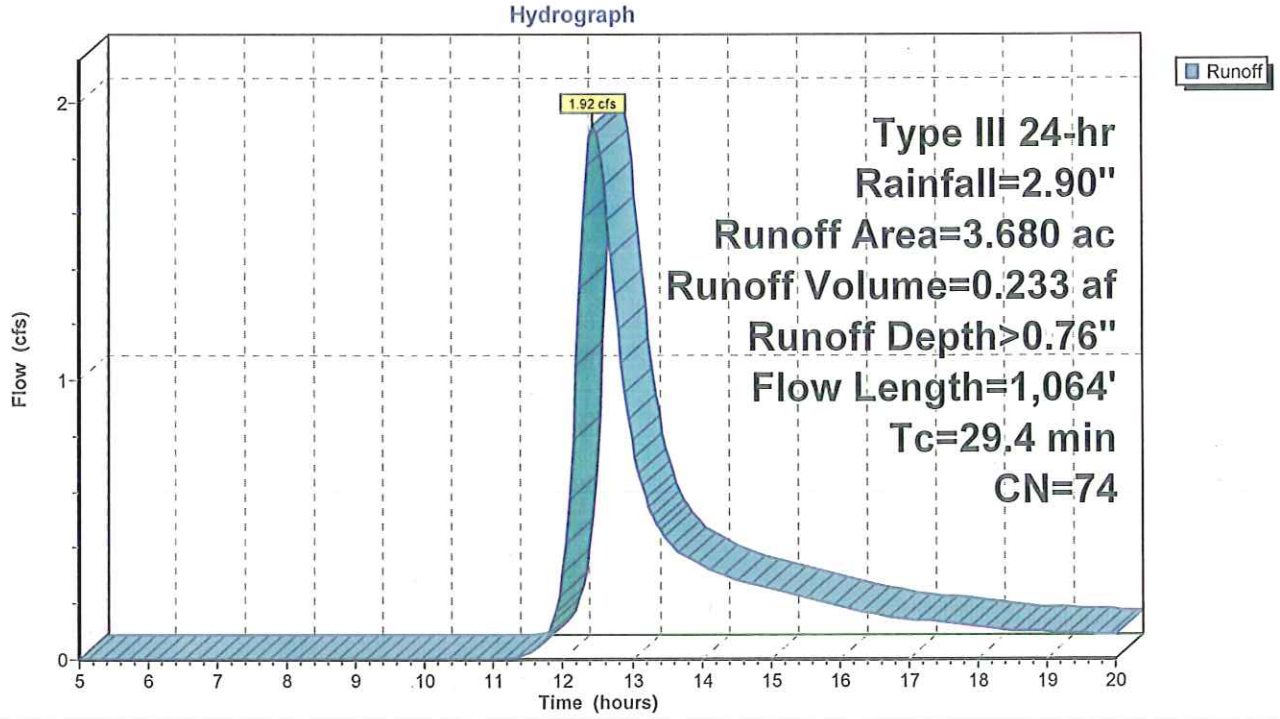
Runoff = 1.92 cfs @ 12.46 hrs, Volume= 0.233 af, Depth> 0.76"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr Rainfall=2.90"

Area (ac)	CN	Description
0.200	98	Paved roads w/curbs & sewers, HSG D
0.360	89	Gravel roads, HSG C
3.120	71	Meadow, non-grazed, HSG C
3.680	74	Weighted Average
3.480		94.57% Pervious Area
0.200		5.43% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.2	104	0.0200	0.11		**Sheet Flow, MEADOW** Grass: Dense n= 0.240 P2= 3.00"
0.1	31	0.2500	3.50		**Shallow Concentrated Flow, 4:1 SLOPE** Short Grass Pasture Kv= 7.0 fps
12.8	669	0.0155	0.87		**Shallow Concentrated Flow, MEADOW** Short Grass Pasture Kv= 7.0 fps
1.0	129	0.0930	2.13		**Shallow Concentrated Flow, MEADOW** Short Grass Pasture Kv= 7.0 fps
0.3	131	0.0530	6.42	43.02	**Channel Flow, RIP RAP CHANNEL** Area= 6.7 sf Perim= 10.3' r= 0.65' n= 0.040 Earth, cobble bottom, clean sides
29.4	1,064	Total			

Subcatchment 2S: AREA 2



Summary for Pond 3P: DROP INLET

Inflow Area =	7.980 ac,	0.00% Impervious,	Inflow Depth >	0.86"
Inflow =	8.00 cfs @	12.11 hrs, Volume=	0.575 af	
Outflow =	7.55 cfs @	12.17 hrs, Volume=	0.571 af,	Atten= 6%, Lag= 3.3 min
Primary =	3.81 cfs @	12.17 hrs, Volume=	0.527 af	
Secondary =	3.74 cfs @	12.17 hrs, Volume=	0.044 af	

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 273.04' @ 12.17 hrs Surf.Area= 5,249 sf Storage= 2,892 cf

Plug-Flow detention time= 10.8 min calculated for 0.570 af (99% of inflow)
Center-of-Mass det. time= 8.5 min (827.2 - 818.8)

Volume	Invert	Avail.Storage	Storage Description
#1	271.95'	9,459 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

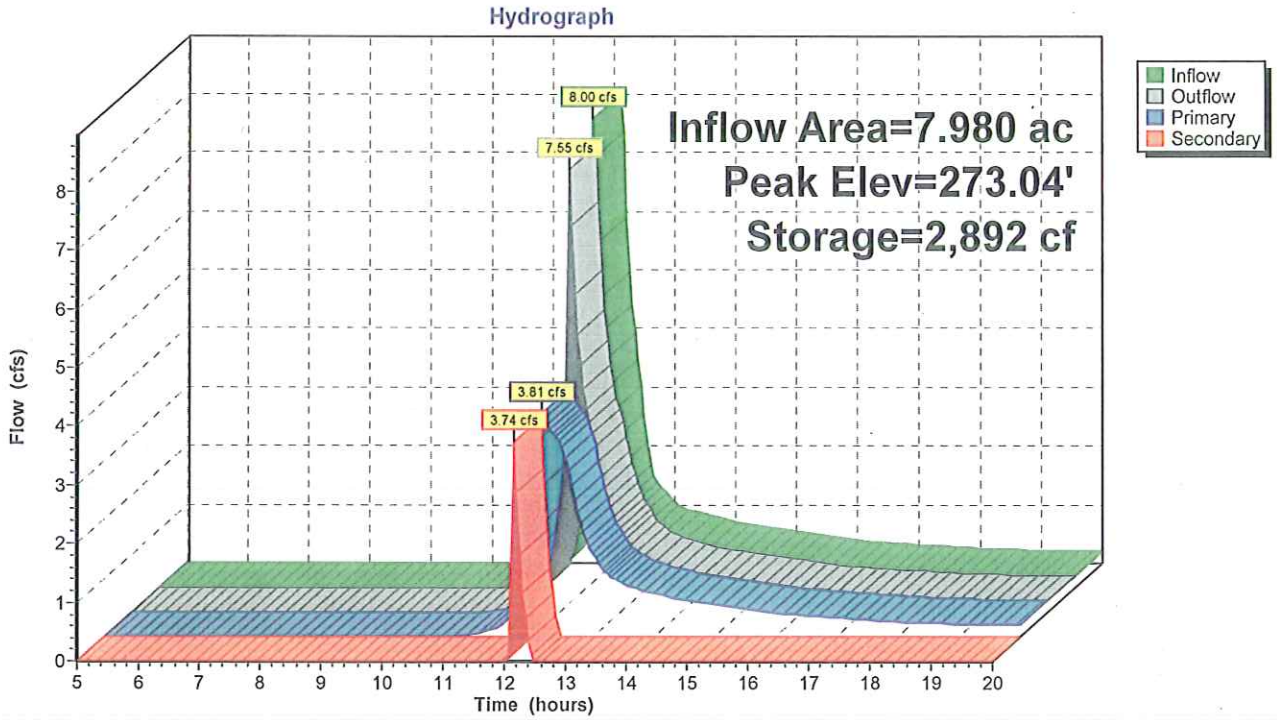
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
271.95	0	0	0
272.95	4,831	2,416	2,416
273.95	9,256	7,044	9,459

Device	Routing	Invert	Outlet Devices
#1	Primary	272.00'	**15.0" Round Culvert** L= 26.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 272.00' / 269.00' S= 0.1154 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean
#2	Secondary	272.95'	**50.0' long x 18.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=3.76 cfs @ 12.17 hrs HW=273.03' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 3.76 cfs @ 3.46 fps)

Secondary OutFlow Max=3.27 cfs @ 12.17 hrs HW=273.03' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 3.27 cfs @ 0.78 fps)

Pond 3P: DROP INLET



Summary for Pond 4P: STORMWATER BASIN

Inflow Area = 11.660 ac, 1.72% Impervious, Inflow Depth > 0.83"
Inflow = 8.43 cfs @ 12.17 hrs, Volume= 0.804 af
Outflow = 0.08 cfs @ 20.00 hrs, Volume= 0.049 af, Atten= 99%, Lag= 469.8 min
Primary = 0.08 cfs @ 20.00 hrs, Volume= 0.049 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 263.87' @ 20.00 hrs Surf.Area= 16,547 sf Storage= 32,892 cf

Plug-Flow detention time= 266.9 min calculated for 0.049 af (6% of inflow)
Center-of-Mass det. time= 146.3 min (977.4 - 831.1)

Volume	Invert	Avail.Storage	Storage Description
#1	261.00'	53,307 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

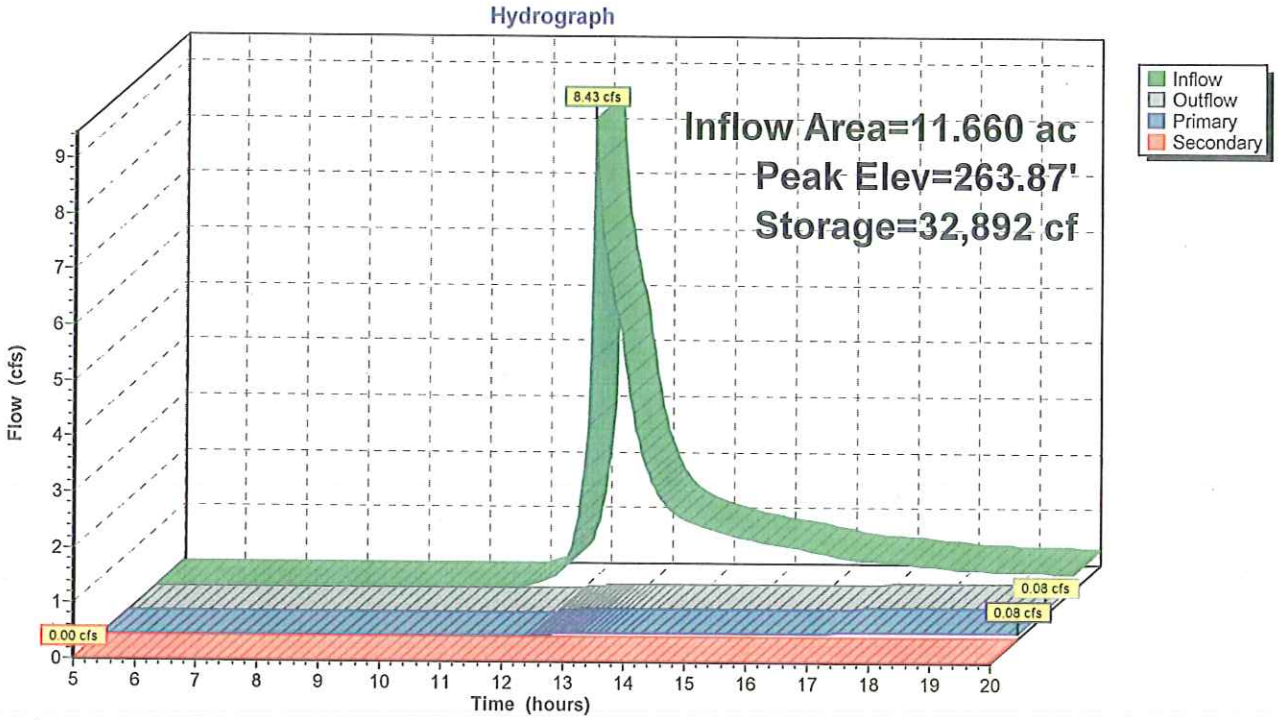
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
261.00	0	0	0
262.00	12,326	6,163	6,163
263.00	14,274	13,300	19,463
264.00	16,882	15,578	35,041
265.00	19,650	18,266	53,307

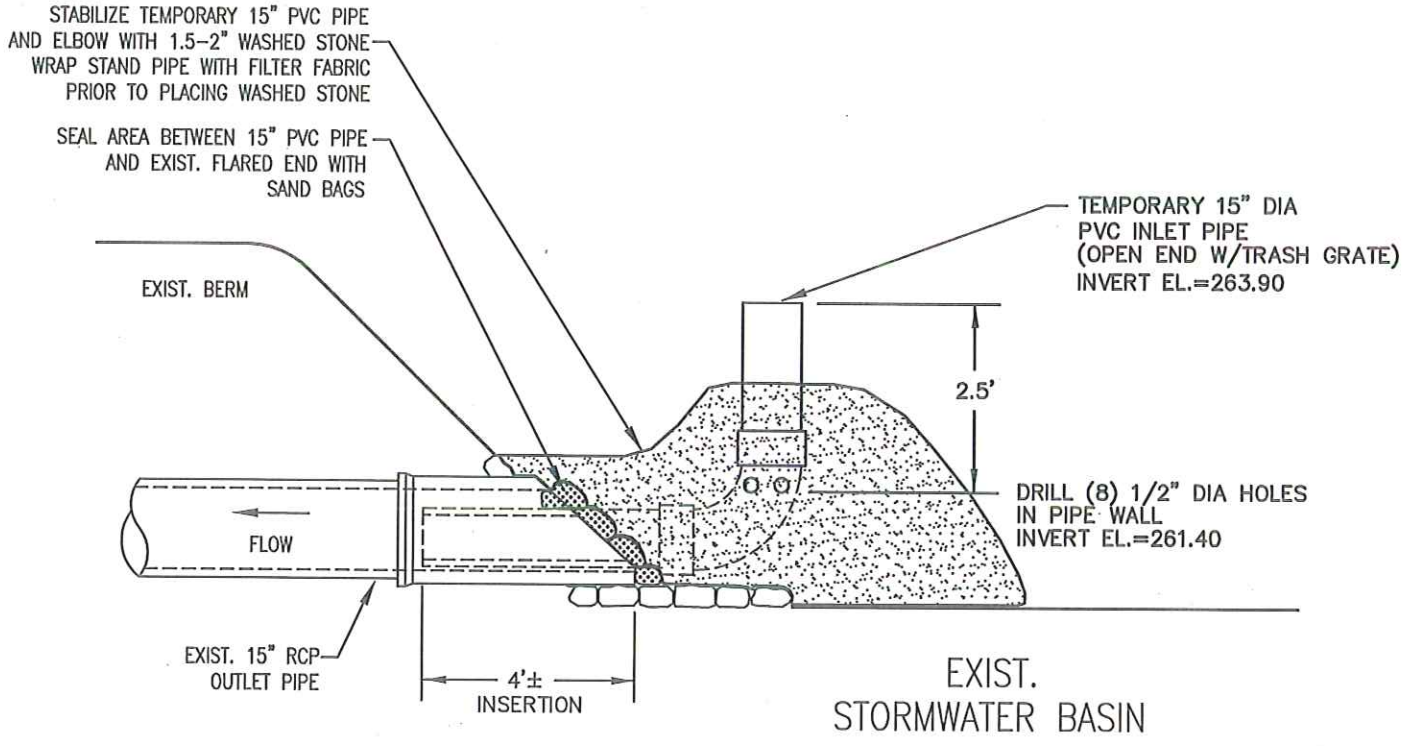
Device	Routing	Invert	Outlet Devices
#1	Primary	260.90'	**15.0" Round Culvert** L= 100.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 260.90' / 260.80' S= 0.0010 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean
#2	Device 1	263.90'	**15.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	261.40'	**0.5" Vert. (8) 1/2" DIA HOLES X 8.00** C= 0.600
#4	Secondary	264.90'	**48.0' long x 12.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.57 2.62 2.70 2.67 2.66 2.67 2.66 2.64

Primary OutFlow Max=0.08 cfs @ 20.00 hrs HW=263.87' (Free Discharge)
└**1=Culvert** (Passes 0.08 cfs of 7.47 cfs potential flow)
  ├**2=Orifice/Grate** (Controls 0.00 cfs)
  └**3=(8) 1/2" DIA HOLES** (Orifice Controls 0.08 cfs @ 7.54 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=261.00' (Free Discharge)
└**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 4P: STORMWATER BASIN





NOTES:

1. MODIFY EXITING STORMWATER BASIN INTO TEMPORARY SEDIMENTATION BASIN PRIOR TO THE START OF CONSTRUCTION.
2. SEDIMENT TO BE REMOVED FROM BASIN WHEN ACCUMULATED DEPTH REACHES 6"
3. BASIN TO BE RESTORED TO ORIGINAL CONDITION AFTER COMPLETION OF ALL SITE WORK AND ONCE SITE VEGETATION IS PERMANENTLY ESTABLISHED

MODIFICATION TO EXISTING STORMWATER BASIN OUTLET

N.T.S.

AMHERST, MASSACHUSETTS FOUNDED 1759	DRAWN BY: PGD DATE: 2/17/10 REV. DATE: APPROVED BY:	PROJECT BWP SW11 LANDFILLS MAJOR MODIFICATION PERMIT AMHERST LANDFILL OLD BELCHERTOWN ROAD AMHERST, MASSACHUSETTS	SHT. NAME MODIFICATION TO EXISTING STORMWATER BASIN OUTLET